converter converting signal light into converted signal light by nonlinear optical effect based on said signal light and pump light;

A3 Concl'd

wherein the product of the average of optical powers in said first fiber span, the average of nonlinear coefficients in said first fiber span, and the length of said first fiber span is substantially equal to the product of the average of optical powers in said second fiber span, the average of nonlinear coefficients in said second fiber span, and the length of said second fiber span.

REMARKS

I. STATUS OF THE CLAIMS

Claims 1-19, 21- 26, and 34-40 are pending. Claims 1-13 were allowed, claim 20 was cancelled, claims 14 and 34 have been amended, and claims 35-40 have been added.

II. REJECTION OF CLAIMS 14, 15, 18, AND 21 UNDER 35 USC 102 AS ANTICIPATED BY KUROKAWA

Claim 14 has been amended to incorporate the features of objected to claim 20. In view of the above, it is respectfully submitted that the rejection is overcome.

III. REJECTION OF CLAIM 34 UNDER 35 USC 102 AS ANTICIPATED BY BERGANO

In the Office Action at page 3, the Examiner rejected claim 34 as anticipated by Bergano at col. 3, line 57 to col. 4, line 4 and col. 10 lines 34-36.

Amended independent claim 34 recites a device that includes a polarization beam splitter having first, second, and third ports, and a polarization maintaining fiber having first and second ends, the first end connected to the second port and the second end connected to the third port. Application at page 24 and Fig. 1.

Bergano shows a device that includes a polarization beam splitter having first, second, and third ports and first and second polarization maintaining optical fibers respectively coupled to said first and third ports. Bergano at Fig. 3. However, Bergano does not disclose a polarization maintaining fiber having first and second ends, the first end connected to the second port and the second end connected to the third port. Instead, Bergano shows the first polarization maintaining fiber 306 connected to the first port 1 of the beam splitter 305 and the second polarization maintaining fiber 307 connected to the third port 3 of the polarization beam splitter 305.

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X

In view of the above, it is respectfully submitted that the rejection to claim 34 is overcome.

IV. REJECTION OF CLAIMS 16-17 AND 22-26 UNDER 35 USC 103 AS OBVIOUS OVER KUROKAWA

As noted above, claim 14 has been amended to correspond to "objected to" claim 20. In view of the above, it is respectfully submitted that the rejection is overcome.

V. NEW CLAIMS 35 - 40

New claim 35 corresponds to "objected to" claim 19 written in independent form. Therefore, it is respectfully submitted that the claim should be allowed.

In the Office Action at page 4, the Examiner rejected claims 22-26 as obvious over Kurokawa. The Examiner acknowledged that Kurokawa does not expressly state that repeaters/converters are equidistant, however, he referenced Figs. 44 and 51 in making the rejection. Claims 22-26 were rewritten in independent form as new claims 36-40, respectively. Thus, the discussion of these rejections will be directed to the new claims.

Claims 36-40 recite systems having a first fiber network that includes a first fiber span for transmitting signal light and a second optical fiber network with a second fiber span for transmitting converted signal light, the fiber networks each adapted to wavelength division multiplexing. A converter is connected between the first and second optical fiber networks.

Each claim recites various configurations and operating characteristics. For example, claim 36 recites a system wherein when each of said first and second fiber spans is virtually divided into the same number of sections, the product of the average of chromatic dispersions of a first one of said sections of said first fiber span and the length of said first one is substantially equal to the product of the average of chromatic dispersions of a second one of said sections of said second fiber span and the length of said second one, said first and second ones corresponding to each other in order as counted from said converter, and the product of the average of optical powers in said first one, the average of nonlinear coefficients in said first one, and the length of said first one is substantially equal to the product of the average of optical powers in said second one, the average of nonlinear coefficients in said second one, and the length of said second one.

Fig. 44 of Kurokawa shows an apparatus wherein phase modulation is made in the optical signal processing apparatus to scramble the waveform to flatten the optical power,

thereby reducing the peak power of the optical signal. Figure 51 describes an apparatus that multiplexes the optical signal wherein the pulse is divided into n units of modulation circuit to achieve modulation. However, Kurokawa does not describe or suggest a system wherein when each of said first and second fiber spans is virtually divided into the same number of sections, the product of the average of chromatic dispersions of a first one of said sections of said first fiber span and the length of said first one is substantially equal to the product of the average of chromatic dispersions of a second one of said sections of said second fiber span and the length of said second one, said first and second ones corresponding to each other in order as counted from said converter, and the product of the average of optical powers in said first one, the average of nonlinear coefficients in said first one, and the length of said first one is substantially equal to the product of the average of optical powers in said second one, the average of nonlinear coefficients in said second one, and the length of said second one.

Claim 37 recites a system wherein the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a first point on said first fiber span is substantially equal to the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a second point on said second fiber span, and an accumulated value of chromatic dispersions measured from said converter to said first point being equal to an accumulated value of chromatic dispersions measured from said converter to said second point.

Kurokawa does not describe or suggest a system wherein the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a first point on said first fiber span is substantially equal to the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a second point on said second fiber span, and an accumulated value of chromatic dispersions measured from said converter to said first point being equal to an accumulated value of chromatic dispersions measured from said converter to said second point.

Claim 38 recites a system wherein the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a first point on said first fiber span is substantially equal to the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a second point on said second fiber span, and an accumulated value of the products of optical powers and nonlinear coefficients measured from said converter to said first point being equal to an accumulated value of the products of optical powers and nonlinear coefficients measured from said converter to said second point.

Kurokawa does not describe or suggest a system wherein the ratio of the product of an

optical power and a nonlinear coefficient to a chromatic dispersion at a first point on said first fiber span is substantially equal to the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a second point on said second fiber span, and an accumulated value of the products of optical powers and nonlinear coefficients measured from said converter to said first point being equal to an accumulated value of the products of optical powers and nonlinear coefficients measured from said converter to said second point.

Claim 39 recites a system wherein the product of the average of chromatic dispersions of said first fiber span and the length of said first fiber span is substantially equal to the product of the average of chromatic dispersions of said second fiber span and the length of said second fiber span.

Kurokawa does not describe or suggest a system wherein the product of the average of chromatic dispersions of said first fiber span and the length of said first fiber span is substantially equal to the product of the average of chromatic dispersions of said second fiber span and the length of said second fiber span.

Claim 40 recites a system wherein the product of the average of optical powers in said first fiber span, the average of nonlinear coefficients in said first fiber span, and the length of said first fiber span is substantially equal to the product of the average of optical powers in said second fiber span, the average of nonlinear coefficients in said second fiber span, and the length of said second fiber span.

Kurokawa does not describe or suggest an apparatus wherein the product of the average of optical powers in said first fiber span, the average of nonlinear coefficients in said first fiber span, and the length of said first fiber span is substantially equal to the product of the average of optical powers in said second fiber span, the average of nonlinear coefficients in said second fiber span, and the length of said second fiber span.

In view of the above, it is respectfully submitted that the rejections are overcome.

VI. CONCLUSION

There being no further outstanding objections or rejections, it is submitted that the application is in condition for allowance. An early action to that effect is courteously solicited.

Finally, if there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

If there are any additional fees associated with filing of this Amendment, please charge

Finally, if there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

STAAS & HALSEY LLP

Date: March 18, 2003

By: Kevin J. McNeely

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please AMEND the following claims:

1. (Original) A device comprising:

an optical circulator having first, second, and third ports, said first port being supplied with signal light including first and second polarization components respectively having first and second polarization planes orthogonal to each other, and with pump light;

a polarization beam splitter having fourth, fifth, and sixth ports, said fourth port being optically connected to said second port, said fourth and fifth

ports being coupled by said first polarization plane, said fourth and sixth ports being coupled by said second polarization plane; and

a polarization maintaining fiber having first and second ends, and having a polarization mode to be maintained between said first and second ends, said first end being optically connected to said fifth port so that said first polarization plane is adapted to said polarization mode, said second end being optically connected to said sixth port so that said second polarization plane is adapted to said polarization mode.

2. (Original) A device according to claim 1, wherein said polarization maintaining fiber has a substantially constant zero-dispersion wavelength in relation to said polarization mode, and said pump light has a wavelength

substantially equal to said zero-dispersion wavelength.

3. (Original) A device according to claim 1, wherein said signal light is converted into converted signal light by four-wave mixing based on said signal light and said pump light in said polarization maintaining fiber, said converted signal light being output from said third port of said optical circulator.

4. (Original) A device according to claim 3, wherein said converted signal light is a phase conjugate of said signal light.

5. (Original) A device according to claim 3, wherein:

said pump light has a third polarization plane; said third polarization plane being set so

that the efficiency of conversion from said signal light to said converted signal light is independent of the polarization state of said signal light.

6. (Original) A device according to claim 3, wherein said signal light, said pump light, and said converted signal light have angular frequencies ω_s, ω_p, and ω_C, respectively,

said angular frequencies ω_s, ω_p, and ω_c substantially satisfying the relation of $2\omega_p = \omega_S + \omega_C$.

7. (Original) A device according to claim 3, further comprising an optical band-pass filter optically connected to said third port of said optical circulator and having a passband including the wavelength of said converted signal light.

8. (Original) A device according to claim 1, wherein said polarization maintaining fiber has first and second principle axes orthogonal to each other, and said polarization mode corresponds to one of said first and second principal axes.

9. (Original) A device according to claim 1, further comprising: a pumping source for outputting said pump light; and

an optical coupler optically connected to said first port of said optical circulator for combining said signal light and said pump light.

10. (Original) A device according to claim 1, further comprising means for modulating or dithering the frequency or phase of said pump light.

11. (Original) A device comprising:

a polarization beam splitter having first, second, and third ports, said first port being supplied with signal light including first and second polarization components respectively having first and second polarization planes orthogonal to each other, and with pump light, said first and second ports being coupled by said first polarization plane, said first and third ports being coupled by said second polarization plane; and

a polarization maintaining fiber having first and second ends, and having a polarization mode to be maintained between said first and second ends, said first end being optically connected to said second port so that said first polarization plane is adapted to said polarization

mode, said second end being optically connected to said third port so that said second polarization plane is adapted to said polarization mode.

12. (Original) A device according to claim 11, further comprising an optical circulator optically connected to said first port of said polarization beam splitter.

13. (Original) A device according to claim 11, wherein said polarization maintaining fiber has a substantially constant zero-dispersion wavelength in relation to said polarization mode, and said pump light has a wavelength substantially equal to said zero-dispersion wavelength.

14. (Currently amended) A system comprising:

first and second optical fiber networks each adapted to wavelength division multiplexing; and

a converter connected between said first and second optical fiber networks, said converter converting signal light into converted signal light by nonlinear optical effect based on said signal light and pump light, wherein said converter comprises:

a pumping source for outputting pump light;

an optical circulator having first, second, and third ports, said first port being supplied with signal light including first and second polarization components respectively having first and second polarization planes orthogonal to each other, and with said pump light;

a polarization beam splitter having fourth, fifth, and sixth ports, said fourth port being optically connected to said second port, said fourth and fifth ports being coupled by said first polarization plane, said fourth and sixth ports being coupled by said second polarization plane; and

a polarization maintaining fiber having first and second ends, and having a polarization mode to be maintained between said first and second ends, said first end being optically connected to said fifth port so that said first polarization plane is adapted to said polarization mode, said second end being optically connected to said sixth port so that said second polarization plane is adapted to said polarization mode.

15. (Original) A system according to claim 14, wherein said signal light is converted into said converted signal light by a second-order or third order nonlinear optical effect.

16. (Original) A system according to claim 14, wherein said signal light is converted into said converted signal light by four-wave mixing based on said signal light and said pump light

17. (Original) A system according to claim 14, wherein said converted signal light is a phase conjugate of said signal light.

18. (Original) A system according to claim 14, wherein said signal light is WDM signal light obtained by wavelength division multiplexing a plurality of optical signals having different wavelengths.

19. (Original) A system according to claim 18, wherein the wavelengths of said plurality of optical signals are arranged at unequal intervals.

20. (Cancelled)

21. (Original) A system according to claim 14, wherein:

said first optical fiber network includes a first fiber span for transmitting said signal light; and

said second optical fiber network includes a second fiber span for transmitting said converted signal light.

22. (Original) A system according to claim 21, wherein when each of said first and second fiber spans is virtually divided into the same number of sections, the product of the average of chromatic dispersions of a first one of said sections of said first fiber span and the length of said first one is substantially equal to the product of the average of chromatic dispersions of a second one of said sections of said second fiber span and the length of said

second one, said first and second ones corresponding to each other in order as counted from said converter, and the product of the average of optical powers in said first one, the average of nonlinear coefficients in said first one, and the length of said first one is substantially equal to the product of the average of optical powers in said second one, the average of nonlinear coefficients in said second one, and the length of said second one.

23. (Original) A system according to claim 21, wherein:

the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a first point on said first fiber span is substantially

equal to the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a second point on said second fiber span;

an accumulated value of chromatic dispersions measured from said converter to said first point being equal to an accumulated value of chromatic dispersions measured from said converter to said second point.

24. (Original) A system according to claim 21, wherein:

the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a first point on said first fiber span is substantially

equal to the ratio of the product of an optical power and

a nonlinear coefficient to a chromatic dispersion at a second point on said second fiber span;

an accumulated value of the products of optical powers and nonlinear coefficients measured from said converter to said first point being equal to an accumulated value of the products of optical powers and nonlinear coefficients measured from said converter to said second point.

25. (Original) A system according to claim 21, wherein the product of the average of chromatic dispersions of said first fiber span and the length of said first fiber span is substantially equal to the product of the average of chromatic dispersions of said second fiber span and the length of said second fiber span.

26. (Original) A system according to claim 21, wherein the product of the average of optical powers in said first fiber span, the average of nonlinear coefficients in said first fiber span, and the length of said first fiber span is substantially equal to the product of the average of optical powers in said second fiber span, the average of nonlinear coefficients in said second fiber span, and the length of said second fiber span.

27. (Withdrawn) A device comprising:

a first optical circulator having first, second, and third ports, said first port being supplied with

first signal light including first and second polarization components respectively having first and second polarization planes orthogonal to each other, and with first pump light;

a second optical circulator having fourth, fifth, and sixth ports, said fourth port being supplied with second signal light including third and fourth polarization components respectively having third and fourth polarization planes orthogonal to each other, and with second pump light;

a polarization beam splitter having seventh, eighth, ninth, and tenth ports, said seventh port being optically connected to said second port, said tenth port being optically connected to said fifth port, said seventh and eighth ports being coupled by said first polarization plane, said seventh and ninth ports being coupled by said second polarization plane, said ninth and tenth ports being coupled by said third polarization plane, said eighth and tenth ports being coupled by said fourth polarization plane; and

a polarization maintaining fiber having first and second ends, and having first and second polarization modes to be maintained between said first and second ends, said first end being optically connected to said seventh port so that said first and fourth polarization planes

are respectively adapted to said first and second polarization modes, said second end being optically connected to said eighth port so that said second and third polarization planes are respectively adapted to said first and second polarization modes.

28. (Withdrawn) A device according to claim 27, wherein said polarization maintaining fiber has a substantially constant zero-dispersion wavelength in relation to each of said first and second polarization modes, and each of said first and second pump lights has a wavelength substantially equal to said zero-dispersion wavelength.

29. (Withdrawn) A device according to claim 27, wherein:

said first signal light is converted into first converted signal light by four-wave mixing based on said first signal light and said first pump light in said polarization maintaining fiber, said first converted signal light being output from said third port of said first optical circulator; and

said second signal light is converted into second converted signal light by four-wave mixing based on said second signal light and said second pump light in said polarization maintaining fiber, said second converted signal light being output from said sixth port of said second optical circulator.

30. (Withdrawn) A device according to claim 29, wherein said first

and second converted signal lights are phase conjugates of said first and second signal lights, respectively.

31. (Withdrawn) A system comprising:

first and second optical fiber networks each adapted to wavelength division multiplexing; and

a converter connected between said first and second optical fiber networks;

said converter comprising:

first and second pumping sources for outputting first and second pump lights, respectively;

a first optical circulator having first, second, and third ports, said first port being supplied with first signal light including first and second polarization components respectively having first and second polarization planes orthogonal to each other, and with said first pump light;

a second optical circulator having fourth, fifth, and sixth ports, said fourth port being supplied with second signal light including third and fourth polarization components respectively having third and fourth polarization planes orthogonal to each other, and with said second pump light;

a polarization beam splitter having seventh, eighth, ninth, and tenth ports, said seventh port being optically connected to said second port, said tenth port being

optically connected to said fifth port, said seventh and eighth ports being coupled by said first polarization plane, said seventh and ninth ports being coupled by said second polarization plane, said ninth and tenth ports being coupled by said third polarization plane, said eighth and tenth ports being coupled by said fourth polarization plane; and

a polarization maintaining fiber having first and second ends, and having first and second polarization modes to be maintained between said first and second ends, said first end being optically connected to said seventh port so that said first and fourth polarization planes are respectively adapted to said first and second polarization modes, said second end being optically connected to said eighth port so that said second and third polarization planes are respectively adapted to said first and second polarization modes.

32. (Withdrawn) A system according to claim 31, wherein:

said first signal light is converted into first converted signal light by four-wave mixing based on said first signal light and said first pump light in said polarization maintaining fiber, said

first converted signal light being output from said third port of said first optical circulator; and

said second signal light is converted into second

converted signal light by four-wave mixing based on said second signal light and said second pump light in said polarization maintaining fiber, said second converted signal light being output from said sixth port of said second optical circulator.

33. (Withdrawn) A system according to claim 31, wherein said first and second converted signal lights are phase conjugates of said first and second signal lights, respectively.

34. (Currently amended) A device comprising:

a polarization beam splitter having first, second, and third ports, said first and second ports being coupled by a first polarization plane, said first and third ports being coupled by a second polarization plane orthogonal to said first polarization plane; and

a polarization maintaining fiber having first and second ends, the first end connected to the second port and the second end connected to the third port, and having a polarization mode to be maintained between said first and second ends, said polarization maintaining fiber being supplied with signal light including first and second polarization components respectively having said first and second polarization planes, and with pump light;

said signal light being converted into converted signal light by nonlinear optical effect based on said signal light and pump light in said polarization maintaining fiber.

Please ADD the following claims:

35. (New) A system comprising:

first and second optical fiber networks each adapted to wavelength division multiplexing; and

a converter connected between said first and second optical fiber networks, said converter converting signal light into converted signal light by nonlinear optical effect based on said signal light and pump light, wherein said signal light is WDM signal light obtained by wavelength division multiplexing a plurality of optical signals having different wavelengths and arranged at unequal intervals.

36. (New) A system comprising:

first and second optical fiber networks each adapted to wavelength division multiplexing

wherein:

said first optical fiber network includes a first fiber span for transmitting said signal light; and

said second optical fiber network includes a second fiber span for transmitting said converted signal light; and

a converter connected between said first and second optical fiber networks, said converter converting signal light into converted signal light by nonlinear optical effect based on said signal light and pump light;

wherein when each of said first and second fiber spans is virtually divided into the same number of sections, the product of the average of chromatic dispersions of a first one of said sections of said first fiber span and the length of said first one is substantially equal to the product of the average of chromatic dispersions of a second one of said sections of said second fiber span and the length of said second one, said first and second ones corresponding to each other in order as counted from said converter, and the product of the average of optical powers in said first one, the average of nonlinear coefficients in said first one, and the length of said first one is substantially equal to the product of the average of optical powers in said second one, the average of nonlinear coefficients in said second one, and the length of said second one.

37. (New) A system comprising:

first and second optical fiber networks each adapted to wavelength division multiplexing wherein:

said first optical fiber network includes a first fiber span for transmitting said signal light; and

said second optical fiber network includes a second fiber span for transmitting said converted signal light; and

a converter connected between said first and second optical fiber networks, said converter converting signal light into converted signal light by nonlinear optical effect based on said signal light and pump light;

wherein:

the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a first point on said first fiber span is substantially equal to the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a second point on said second fiber span; and

an accumulated value of chromatic dispersions measured from said converter to said first point being equal to an accumulated value of chromatic dispersions measured from said converter to said second point.

38. (New) A system comprising:

first and second optical fiber networks each adapted to wavelength division multiplexing wherein:

said first optical fiber network includes a first fiber span for transmitting said signal light; and

said second optical fiber network includes a second fiber span for transmitting said converted signal light; and

a converter connected between said first and second optical fiber networks, said converter converting signal light into converted signal light by nonlinear optical effect based on said signal light and pump light;

wherein:

the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a first point on said first fiber span is substantially equal to the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a second point on said second fiber span; and

an accumulated value of the products of optical powers and nonlinear coefficients measured from said converter to said first point being equal to an accumulated value of the products of optical powers and nonlinear coefficients measured from said converter to said second point.

39. (New) A system comprising:

first and second optical fiber networks each adapted to wavelength division multiplexing wherein:

said first optical fiber network includes a first fiber span for transmitting said signal light; and

said second optical fiber network includes a second fiber span for transmitting said converted signal light; and

a converter connected between said first and second optical fiber networks, said converter converting signal light into converted signal light by nonlinear optical effect based on

said signal light and pump light;

wherein the product of the average of chromatic dispersions of said first fiber span and the length of said first fiber span is substantially equal to the product of the average of chromatic dispersions of said second fiber span and the length of said second fiber span.

40. (New) A system comprising:

first and second optical fiber networks each adapted to wavelength division multiplexing wherein:

said first optical fiber network includes a first fiber span for transmitting said signal light; and

said second optical fiber network includes a second fiber span for transmitting said converted signal light; and

a converter connected between said first and second optical fiber networks, said converter converting signal light into converted signal light by nonlinear optical effect based on said signal light and pump light;

wherein the product of the average of optical powers in said first fiber span, the average of nonlinear coefficients in said first fiber span, and the length of said first fiber span is substantially equal to the product of the average of optical powers in said second fiber span, the average of nonlinear coefficients in said second fiber span, and the length of said second fiber span.